

## Adult Behavior and Population Biology of *Poladryas minuta*, and the Relationship of the Texas and Colorado Populations

(Lepidoptera: Nymphalidae)

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This paper is part of a comparative study of behavior and movements of eleven species of diurnal lepidoptera (Hesperiidae and Papilionoidea), emphasizing the relationship between mate-locating behavior and movements (Scott, 1973a; 1973b). Included are studies of mate-locating behavior by males, mating, movements and lifespan, oviposition, adult and larval foodplants, and basking behavior in *Poladryas minuta* Edwards. In addition I describe experiments in which the Texas subspecies (*minuta*) was hybridized and backcrossed in nature to the Colorado subspecies (*arachne* Edwards), providing much of the behavioral information.

The species was studied in 1969 on a treeless ridge just northwest of Cripple Creek, Teller County, Colorado, and in 1972 on Green Mountain, Jefferson County, Colorado. All times are 24-hour standard time.

I thank Roy O. Kendall, San Antonio, Texas, and Kilian Roever, Phoenix, Arizona, for helpful information, Jerry A. Powell, University of California, Berkeley, and Glenn R. Scott, Lakewood, Colorado, for reviewing parts of the manuscript. The University of California, Berkeley, provided a grant for computer time.

### METHODS

Felt-tipped markers were used to give each individual a different number using the method of Ehrlich & Davidson (1960). Marks were placed on the upperside so that the number could usually be determined without capture. Individuals were marked and individually released at the site of capture.

The following method of analysis of movements allows direct comparison between sexes and between species, detection of change of movements with age, and separation of the velocity and distance aspects of movements. The capture points for each individual are plotted on separate maps of the study site. The following statistics were determined for each individual:

$d_i$ ,  $t_i$ —distance in meters and time in days between capture  $i$  and capture  $(i + 1)$ ;  $D$ —sum of all  $d$ 's of an individual;  $R$ —distance between

the two farthest capture points (range); T—time between first and last capture; V—overall velocity ( $D/T$ );  $v_i$ —velocity between successive captures ( $d_i/t_i$ ).

Means of the above statistics are computed for all individuals of each sex. Midpoint age is the age midway between two successive captures of an individual. Correlations between the above movement parameters and age determine whether movement changes with age. Population size, survival rates, and number of new insects per day were determined from mark-recapture data using the method of Jolly (1966).

#### MATE-LOCATING BEHAVIOR

Most butterflies use one of two strategies to bring the sexes together for mating (Scott, 1973b): in some species males wait at characteristic sites such as hilltops, gullies, or treetops, and locate females by investigating passing objects (*perching behavior*). In these species females fly to the perching sites after emergence. In other species males search for females by flying almost continuously (*patrolling behavior*). *P. minuta* is the only known species of butterfly (and perhaps insect) which utilizes completely different strategies of mate-location depending on the time of day. In the morning from about 0700 to about 1215 and especially from 0800 to 1130, male *P. m. arachne* perch on hilltops and high points on ridges. In the afternoon until about 1600, males patrol near flowers, usually on hillsides or flats. Male *P. m. minuta* in Texas also perch in the morning on ridgetops and patrol in the afternoon on hillsides.

In the morning, perching males alight on bare spots or rocks and dart out at passing fluttering objects (usually other male *P. minuta*, and often males of *Hesperia comma* L., another perching, hilltopping species). Between investigative flights, males often visit flowers or fly short distances to adjacent perches. If they encounter a female during these short flights courtship ensues, resulting in the small percentage of morning copulations initiated by flying males. If a male investigates an adjacent perched male, an "encounter" usually results in which both fly vertically near each other for about 3 m, then separate and return to the ground or repeat the vertical flight. Passing males may be pursued briefly. Males usually return to the same or a nearby perch after investigating a passing object, but sometimes move to another spot on the ridge. In the afternoon, the behavior of males changes radically: males patrol rapidly near flowers, briefly pursuing male *P. minuta* or other butterflies and courting females.

Experiments with females dangling from a fishing pole showed that movement of the wings is necessary to attract a perched male. When the female fluttered, the male approached and then courted if the female was dropped to the ground. Usually the female hung motionless, and was ignored by males, which would sometimes pass by the motionless female to investigate a more distant much larger black *Papilio* butterfly (*minuta* is mottled orange). Flight is not an absolute requirement to attract the male, since in two instances courtship commenced when a female was carefully placed next to a perched male without disturbing him.

### MATING

Virgin females were released before perched males for analysis of courtship, and many courtships of native individuals were also observed. To obtain pure *minuta* matings, the male was released first, then the female was released near the perched male. Thirty-two completed courtships in five male-female combinations (three pure combinations: *minuta* ♂ × *minuta* ♀ (1), *minuta nympha* Edwards ♂ × *m. nympha* ♀ (1), *arachne* ♂ × *arachne* ♀ (3); two hybrid combinations: *arachne* ♂ × *minuta* ♀ (12), *arachne* ♂ × (*arachne* ♂ × *minuta* ♀) ♀ (15)) and many abortive courtships were observed. Courtship in these five combinations was identical, including all the behavioral elements described below.

In the simplest form of courtship the female alights (usually within 3 m of the male's perch), the male alights behind her and bends his abdomen laterally (11 right, 7 left in successful attempts) to copulate. Four additional components may be present. *Male hovering* consists of the male rapidly beating his wings at small amplitude a few cm above and downwind of the female for a few seconds. The male then alights behind the female. If the female flies, crawls vigorously away, or flutters during courtship, the male may hover before alighting behind her again. *Male fluttering* is similar to hovering except that the male is on the ground so the wings are moved more slowly, above the horizontal, and with greater amplitude while the body remains stationary. Male fluttering occurred rarely (only 4 successful copulations) and only after alighting while the male was behind the female prior to attempted copulation. *Male nudging* consists of the male holding the wings about 40° above horizontal, the antennae directed backward, and pushing his head under a spread hind wing of a female, evidently positioning him alongside the female so that his laterally curved ab-

domen is in position for copulation. If the female's wings are nearly closed the male immediately crawls alongside and attempts coupling. The male usually keeps his wings about  $40-60^\circ$  above horizontal even when it would appear advantageous to raise them to get closer to the female. Male nudging was observed in many successful courtships, especially early in courtship when the female's wings were spread. Females usually raised their wings prior to coupling but several males managed to couple by nudging under the female's spread wings. *Female fluttering* consists of females holding the wings about  $40^\circ$  above horizontal and fluttering the wings slightly. It occurs while the male is on the ground behind the female.

Successful courtship last from 2 seconds to 2 minutes after both individuals alight, but typically requires about 10-15 sec.

Unreceptive virgin females discourage males in a variety of ways. They may crawl away, turn, fly a short distance, or flutter their wings (female fluttering); they rarely perform the stereotyped rejection dance of mated females (performed early in three successful courtships; see below). Occasionally they may lift the abdomen about  $30^\circ$  above horizontal so that the male cannot couple, and they usually keep the wings spread. Males often overcome moderate female unreceptivity by persistent hovering, nudging, and attempted coupling. The male crawls or flies behind the female, often hovering briefly when the female flies or crawls rapidly away, or sometimes he hovers after she flutters her wings. After many copulation attempts (up to 20-30), the female may become quiescent, raising her wings nearly to the vertical, and moving her abdomen to the horizontal or slightly below so that the male can couple. One female whose wings remained spread raised her abdomen slightly to nearly horizontal so that the nudging male could couple. The main causes of courtship termination by virgin females are: 1) the female eludes the male by crawling or flying so that the male cannot relocate her; 2) after courting a persistently unreceptive female the male flies away.

Table 1 shows that male hovering and fluttering are associated with crawling, flying, or fluttering in unreceptive virgin females. In only five courtships was male hovering or fluttering not associated with these female responses. The function of hovering and fluttering seems to be to inform the female of the identity of the male and thereby to make her more receptive, but the male often hovered before landing and before the female could respond, suggesting that male hovering has become somewhat ritualized.



TABLE 1. Association of some of the behavioral elements of courtship in *Poladryas minuta* subspecies, based on 32 successful courtships with virgin females. Females less than two hours old indicated by (y); two days old, (o); other females were one day old. See text for descriptions of male and female behavioral elements.

|                 |                         | Male Behavior |            | Hovering & Fluttering | Other* | Total |
|-----------------|-------------------------|---------------|------------|-----------------------|--------|-------|
|                 |                         | Hovering      | Fluttering |                       |        |       |
| Female Response | Flying                  | 3(1y)         |            |                       | 1      | 4     |
|                 | Fluttering              | 2             |            |                       |        | 2     |
|                 | Crawling                | 2(1y)         | 1          | 1                     |        | 4     |
|                 | Flying and Fluttering   | 1             |            |                       |        | 1     |
|                 | Flying and Crawling     | 3(1y)         |            | 1                     |        | 4     |
|                 | Fluttering and Crawling | 5(3y,1o)      |            |                       | 1(o)   | 6     |
|                 | None                    | 4(1y,1o)      |            | 1                     | 6(2o)  | 11    |
|                 | Total                   | 20            | 1          | 3                     | 8      | 32    |

\* Includes nudging or absence of preliminary courtship.

Females mated at ages of one hour to two days. Table 1 shows that young females were somewhat less receptive than older females, and that males hover slightly less frequently over older females. Males begin courting on the day of emergence, as one *P. m. minuta* male perched and chased 10 objects on a hilltop in a half hour period two hours after emergence, and attempted to copulate with a female. Another *P. m. minuta* male mated one day after emergence.

Mated, unreceptive females have a rather stereotyped *rejection dance*. The female, when pursued by a male, slowly flies vertically about three m, then rapidly returns to the ground. The male frequently cannot follow her through the downward part of this flight. The dance is repeated if the male follows her. This dance is almost identical to the vertical encounter between two perched males, suggesting that the visual similarity may function in discouraging courting males. The female rejection dance occurs in all four taxa studied, and in *P. m. nympa* in southern Arizona (Fred Thorne, written communication).

Many of the elements of behavior during courtship seem to depend on visual cues. The perched male is attracted only to moving objects.

The rejection dance of mated females visually resembles the vertical encounter between adjacent perching males. Males sometimes hover over red *Castilleja* flowers possibly because the colors of the flower and butterfly upperside are similar (*Castilleja* was not used as a nectar source). Perching males often follow other males which have a slow, linear flight similar to that of females, and often land beside very young released males and occasionally hover and try to copulate. One male grasped a newly emerged male for several minutes, but such homosexual behavior is uncommon.

**BEHAVIOR DURING COPULATION.** The male usually remains motionless during copulation but the female often opens and closes her wings a few times after coupling, then usually remains motionless. Upon termination, the male resumes mate-locating behavior, while the female remains motionless for several minutes.

Duration of copulation depends on the history of prior mating of the male. If the male had terminated mating within the previous hour, copulation lasted 9 hr. and 10 hr. 41 min. ( $N = 2$ ). If the male had mated the previous day, copulation lasted an average of 54 minutes (20–82,  $N = 8$ ). If the male had mated more than 1 day before or had no known history of mating, copulation lasted an average of 26 min. (18–49,  $N = 21$ ). Some of the latter males may have mated previously so that duration without recent mating of the male may be significantly less than 26 minutes.

**NUMBER OF MATINGS.** Males may mate at least five times. One native *arachne* male mated 5 times in 4 days, and 4 other *arachne* males mated at least 3 times each. Immediately after mating, males resume perching and courting, and two males mated only 11 and 15 minutes after terminating a previous copulation, but as noted above this resulted in a prolonged mating. Females usually mate only once, very rarely twice. Dissections of 51 field collected females indicated 14 virgins, 36 mated once (one spermatophore), and only one mated twice (a fresh female with two abnormally small spermatophores). The male deposits a clear, solid plug in the female genital orifice. The plug is visible externally, and may act as a mechanical barrier to further mating.

**TIME AND LOCATION OF MATING.** Courting and mating occur throughout the day. Six spontaneous matings were observed in the morning hours, and 29 experimental copulations were induced between 0732 to 1211 by releasing females in front of perching males. Many courtships by perching males were observed from 0756 to 1147, and many courtships by patrolling males were observed from 1300 to 1530. The mating

behavior of males and females remains constant during the day, unlike mate-locating behavior of males, and all types of rejection behavior of females and courtship behavior of males were observed throughout the day. Virgin females were found at all hours, even late in the day, suggesting that some females do not mate until the second day of adult life.

In the morning, all observed matings and courtships except one occurred on the ridgetops. A single mated pair on the hillside was found 100 m east of a Cripple Creek ridgetop indicating that courtship probably occurred on the hillside. Two female *P. m. minuta* two days old left a hilltop after release but later returned and mated there. The percentage of virgin females on ridgetops at Cripple Creek before 1200 was 35% (9 of 26) but only 8% (2 of 24) 20 m or more from a ridgetop. These figures suggest that until females fly to the ridgetops they remain near the sites of emergence, which are mainly on hillsides near *Penstemon*. After mating, females leave the ridgetops. In the afternoon, courtships occur mainly on hillsides and flat areas near the morning perching sites, where virgin and mated females often alight on flowers to feed.

Both sexes usually emerge from pupae before 1100, males an average of a day earlier than females. In the afternoon males apparently actively search for females which emerge that day, then wait on ridges the next morning for the females which did not mate on the day of emergence. Some females may immediately fly to ridgetops, but as shown above females are more receptive a day or more after emergence.

#### MOVEMENTS

In 1969 males were marked and recaptured for 10 days along the top of a ridge at Cripple Creek, mainly in the morning (Fig. 1, Table 2). Males flew along the entire ridgetop, moving a distance (D) up to 470 m. The moderately high density with resultant numerous chases between males may have contributed to the high movement on the ridge, but it is more probable that the movement occurred because the ridge contained suitable perching spots and flowers along most of its length. At the Bear Creek study area described below, the hilltops and perching sites were discontinuous and movement was less. Males are not territorial, as they wandered over the entire ridge and perched wherever suitable sites occurred.

In 1970, 20 males were marked and released at Bear Creek, Chaffee County, Colorado. Six of these were recaptured. Over a two-day pe-

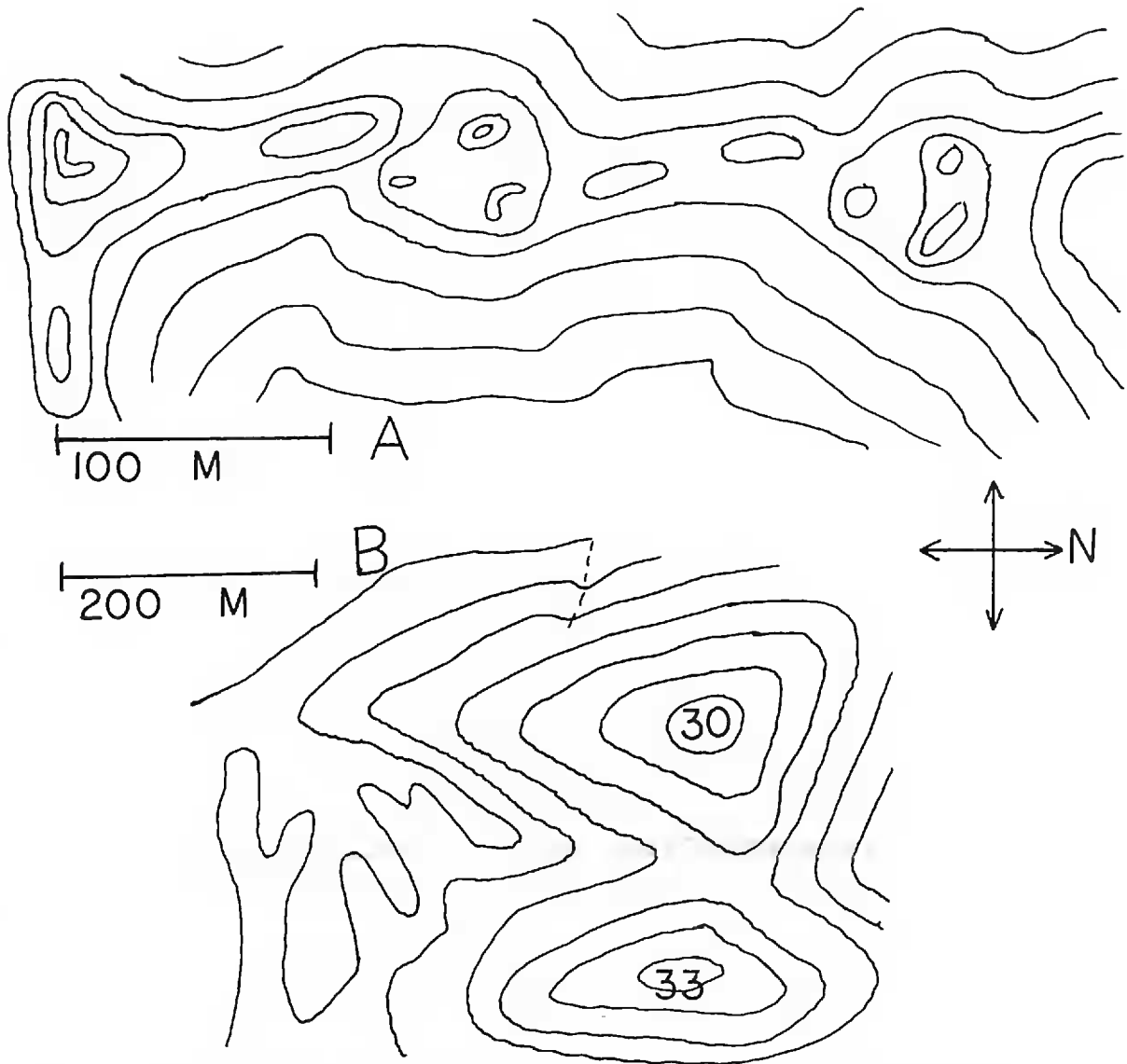


FIG. 1. Maps of Cripple Creek (A) and Bear Creek (B) sites. Contour interval 3 meters (A) and 6 meters (B). Numbered hilltops correspond to foci of activity discussed in text.

riod only one of these males stayed where marked. Two males moved considerable distances from a hilltop to a ridge and vice versa. Three males moved from hilltop 30 (Fig. 1) in the morning to flowers on the hillside in the afternoon; one of these, observed on hilltop 30 in the morning of two successive days, appeared on the hillside visiting flowers on the afternoon of the next day, and returned to hilltop 30 the following morning. Another male remained on hilltop 30 in the morning and the hillside to the west in the afternoon for three days, then was found on hilltop 33 on the sixth day. Still another male resided on hilltop 30 during the mornings of three days in a 4-day span, and moved to the hillside west of hilltop 30 on two afternoons during this time. The last two examples suggest that males return to the same hilltop and hillside areas repeatedly, but this is probably because hilltop 30 and the hill-



TABLE 2. Movement data for *Poladryas minuta arachne* at Cripple Creek in 1969. T = time between first and last capture;  $t_i$ ,  $d_i$  = time, and distance respectively, between capture  $i$  and capture  $(i + 1)$ ; R = distance between the two farthest capture points; D = sum of all  $d$ 's of an individual;  $V = D/T$ ;  $v_i = d_i/t_i$ ; \* =  $p \leq 0.01$  (other correlations  $p > 0.05$ ). Significance of correlations was determined by tests of zero correlation.

| Movement Parameter   | $\bar{x}$ | N                           | Parameter Movement | $\bar{x}$                     | N   |
|--|-----------|-----------------------------|--------------------|-------------------------------|-----|
| T (days)   | 3.66      | 68                          | $d_i$ (meters)     | 56                            | 151 |
| $t_i$ (days)   | 1.65      | 151                         | V (meters/day)     | 42                            | 68  |
| R (meters)   | 93        | 68                          | $v_i$ (meters/day) | 35                            | 151 |
| D (meters)   | 125       | 68                          |                    |                               |     |
| $r(d_i, t_i) = .270^*$   |           | $r(d_i, \text{age}) = .003$ |                    | $r(t_i, \text{age}) = .184$   |     |
| Partial correlation ( $d_i, t_i$ ), age constant = .275*           |           |                             |                    | $r(v_i, \text{age}) = -0.006$ |     |
| Partial correlation ( $d_i, \text{age}$ ), $t_i$ constant = -0.049 |           |                             |                    |                               |     |

side to the west are the most favorable (the most prominent hilltop, and the nearest hillside with many flowers) sites in the immediate vicinity of the Bear Creek locality.

EFFECT OF COPULATION AND AGE ON MOVEMENTS. Males which copulated on Green Mountain were marked and their movements were studied. The results suggest that 1) males do not need to have experience at a site to copulate there, and 2) copulation does not cause the male to remain at that spot. For example, two *arachne* males and a *minuta* male which were caught elsewhere on Green Mountain or laboratory reared were released in the morning on a small ridgetop where they immediately perched and mated within 5 to 15 min. of release. Other *arachne* and *minuta* males perched immediately upon release, showing that, in the morning at least, males perch and mate in suitable topographic sites regardless of "territorial" experience. That males do not remain in areas of previous copulations is shown by their frequent movements. For example, one male mated twice on hill A on one day, flew elsewhere the next day, moved to hill B the third day, mated on hill A the sixth day, then spent the remainder of the sixth day on hill B. Another male mated on hills, A, A, and B on three successive days. Two males mated on hills B, A, and A on successive days; one of these courted on hill A the fourth day. Only one male mated many times on one hill (5 times in 4 days).

TABLE 3. Population parameters of *Poladryas minuta arachne* males at Cripple Creek, 1969, estimated from multiple recapture data using the stochastic model of Jolly (1966). N = total population size; Phi = probability of survival from each sampling period to the next; B = number of new animals joining the population during that sampling period; SE = standard error.

| Day       | N $\pm$ 1.96 SE |       | Phi $\pm$ 1.96 SE |      | B $\pm$ 1.96 SE |       |
|-----------|-----------------|-------|-------------------|------|-----------------|-------|
| August 12 | —               | —     | .727              | .342 | —               | —     |
| 14        | 154.7           | 120.4 | .847              | .381 | 118.9           | 163.9 |
| 15        | 249.1           | 158.6 | .953              | .408 | 7.8             | 160.4 |
| 16        | 245.1           | 131.7 | .637              | .314 | 132.7           | 119.8 |
| 17        | 287.1           | 140.8 | .693              | .441 | 146.9           | 199.9 |
| 18        | 300.0           | 228.5 | .813              | .494 | 63.4            | 188.5 |
| 19        | 273.0           | 151.1 | .923              | .481 | 81.9            | 136.1 |
| 20        | 267.4           | 127.9 | —                 | —    | —               | —     |

Correlations of movement parameters with age for males (Table 2) show positive correlations of  $d_i$  with time between recaptures. Time between captures ( $t_i$ ) increases slightly but not significantly with age, which may indicate less active flight, and hence smaller probability of capture, with age.

#### MALE POPULATION PARAMETERS

A 10 day mark-recapture study of males at the Cripple Creek site indicated a population size of approximately 200, with an initial increase then a decrease (Table 3). An average of about 80 individuals per day joined the population. Average survival rates and expected lifespan were .794 (4.3 days) using method 1, and .817 (5.0 days) using method 2 of Scott (1973a). Probably a small portion of the population emigrated from the area, so that the survival rate should be increased slightly. The potential lifespan is longer than this, of course. The two longest lived males survived at least nine days and nine others seven to eight days. Longer times might have been recorded if the mark-recapture study had been longer.

#### FEEDING AND OVIPOSITION

Individuals of both sexes and all ages frequently visit flowers, especially during the hottest part of the day. Males feed on flowers occasionally during the morning perching period, but more frequently in after-

noon. Both sexes visit yellow flowers most frequently, but also visit flowers of other colors. At Cripple Creek 84 individuals were observed on *Heterotheca villosa* (Pursh) Shinnery and 16 were observed on other yellow flowers, while only 19 visits were recorded to white, orange, or blue flowers. Proportions were similar at other localities.

Oviposition occurs as the female slowly flutters among small *Penstemon* plants which are usually without inflorescences (individuals have never been observed feeding on the flowers, which are blue, white, or red). Eventually she deposits a round cluster averaging 38 eggs (14–87;  $N = 43$ ), usually on the lower surface of one of the lower leaves. Daily egg counts of 16 laboratory reared *P. m. minuta* and  $F_1$  females mated on Green Mountain indicate a preoviposition period of 1–4 (usually 1–3) days. Most females deposited several clusters on the same day or over a period of several days, but several first oviposited on about the third day, then laid other clusters several days later.

**LARVAL FOODPLANTS.** Larvae feed on various *Penstemon* species in different geographic areas, including *P. albidus* Nutt. in Baylor County, Texas (*P. m. minuta*; identified by Roy O. Kendall), *P. dasyphyllis* Gray in Santa Cruz County, Arizona (*P. m. nympha*), *P. virgatus arizonicus* Heller on Mt. Graham, Arizona (*P. m. near arachne*; both Kilian Roever, written communication), and *P. alpinus* Torr. in Larimer County, Colorado (*P. m. arachne*; Sperry & Sperry, 1932). Oviposition was on *P. barbatus torreyi* (Benth.) Keck in Boulder County, Colorado (*P. m. arachne*; Emmel *et al.* 1971), and on *P. secundiflorus* Benth. at Cripple Creek. Many unidentified *Penstemon* were fed to the larvae in the laboratory, with the following general results. The herbaceous or shrubby species with green, mostly hairless, delicate foliage were moderately or very acceptable to the larvae. A cultivated variety (“pin-nifolius”) with small needle-like leaves was moderately acceptable. The herbaceous species with thick leaves covered with a whitish or bluish bloom were completely unacceptable. *P. m. minuta* larvae readily ate the leaves of *P. albidus*, and ate lesser amounts of other *Penstemon* including *P. barbatus*. The  $F_1$ , backcross, and *P. m. arachne* larvae fed readily on most species tested (with the exception of the glaucous species), including *P. barbatus*. The palatability of these *Penstemon* species is similar for grazing animals (Forest Service, 1937), suggesting that grazing may have caused the extinction of *P. m. minuta* over most of its former range in Texas (Kendall, 1971).

First and second instars are gregarious feeders, but later instars become solitary due to mortality and dispersal. Developmental period

from egg to adult ranges from 46 to 57 days indoors at about 20° C (egg stage 8–10 days, pupal stage 11–14 days). There are 4–5 broods in Texas and 2–3 in Colorado, but emergence is asynchronous; distinct broods were vaguely defined at Cripple Creek and almost constant numbers were observed on Green Mountain from early June to early September. Diapause may occur in half-grown larvae.

#### HYBRIDIZATION EXPERIMENTS

Hybridization of these subspecies is significant not only in providing much of the behavioral data presented, but also because they have been considered to be distinct species (Bauer, 1961). *P. m. minuta* was reared from larvae collected in Baylor County, Texas, and females were released in front of wild perching males of *P. m. arachne* on Green Mountain and south of Glenwood Springs, Garfield County, Colorado. Some resultant F<sub>1</sub> females were later mated to wild *arachne* males on Green Mountain and the resulting backcross larvae raised to adults. Sex ratio of F<sub>1</sub> and backcross adults was approximately 1:1. Among 11 *minuta* ♀ (× *arachne* ♂) crosses, two produced no eggs, three infertile eggs, and six fertile eggs which produced adults. Among 14 F<sub>1</sub> ♀ (× *arachne* ♂) crosses, six females failed to oviposit, while eight laid many completely fertile eggs which produced many adults. Among 15 controls (*arachne* ♂ × *arachne* ♀) nine females failed to oviposit, eggs of two females were infertile, offspring of two females died as first or second instar larve (apparently due to disease), and two females produced many viable offspring. *P. m. minuta* and *P. m. arachne* are morphologically very similar. Adults differ slightly in details of wing, antennal and abdominal color pattern, and larvae differ in the ground color between the scoli of the dorsum of late instars (red in *minuta*, largely white in *arachne*). Mr. Jack Harry, Denver, Colorado, collected a large series near Guadeloupe Peak, Culberson County, Texas, which although more similar to *minuta* than *arachne*, is clearly intermediate in several wing pattern characteristics. In addition the two subspecies are very similar in foodplant preferences and in all aspects of courtship behavior, as shown previously. These similarities, together with the high degree of genetic compatibility, clearly demonstrate the conspecificity of these two taxa.

#### DISCUSSION

The most unusual feature of behavior in *P. minuta* is the alteration of mate-locating behavior during the day. This alteration appears to be



well adapted to the search for flowers and virgin females. In the morning, before the females emerging that day are able to fly to ridgetops, males wait for females, which are more active and receptive after their first day of adult life, to come to ridgetops. In afternoon, males search throughout the habitat near flowers, often on hillsides and flats, for virgin females which often feed on flowers at that time. In the morning, temperatures are generally lower than in afternoon; males bask at temperatures too low for prolonged flight. In afternoon higher temperature results in more flower feeding, and enables continuous searching flight.

#### SUMMARY

Males perch on hilltops and ridgetops from 0700 to about 1215 to locate females, and dart out at passing fluttering objects. Females fly to ridgetops to mate. In the afternoon, males patrol on hillsides and flats near flowers in search of females. Courtship is quite variable, as several male and female behavioral elements are present or absent depending partly on the receptivity of the female, which in turn depends partly on age. Unreceptive virgin females have a variety of means of discouraging males, but unreceptive mated females use a stereotyped vertical flight which resembles the encounter between adjacent perching males, and visual stimuli are of general importance both before and during courtship. Males are not territorial. Movement is most pronounced along continuous ridges, decreasing in those habitats with isolated hilltops. Both sexes feed predominantly at yellow flowers. Females deposit clusters averaging 38 eggs on various species of *Penstemon*, usually beginning 2-4 days after emergence. *P. m. minuta* from Texas was hybridized and backcrossed with *P. m. arachne* from Colorado by use of natural courtships. Lack of barriers to interbreeding, and the similarity of adult behavior, larval and adult morphology, and foodplants, confirm the conspecificity of these two allopatric subspecies.

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### SCIENTIFIC NOTE

**Notes on *Hesperus arizonicus* with description of the female (Coleoptera: Staphylinidae).**—*Hesperus arizonicus* was described by Moore in 1958 (*Trans. San Diego Soc. Natur. Hist.* 12: 311) on the basis of a single male specimen from Patagonia, Santa Cruz County, Arizona. A single female specimen in the collection of the University of California at Riverside is from Cave Creek Ranch, elevation 5000', Cochise County, Arizona, taken on August 1, 1965 at ultraviolet light by G. R. Ballmer. It differs from the male in numerous respects.

*Description of the female.* Color largely ferruginous; third through tenth antennomeres dusky; elytra with yellow band across basal third bounded basally and apically by a narrow piceous band, apical third ferruginous; fifth abdominal segment piceous at apical two-thirds; sixth abdominal segment yellow. Head wider than long, slightly wider than pronotum, dorsal surface feebly microreticulate, with coarse punctures generally separated by less than their diameters except for small elongate impunctate central area anteriorly, and area of nearly coalescing punctures behind eyes. Pronotum subquadrate, slightly longer than wide, slightly narrowed behind, sides somewhat sinuate before posterior angles; surface feebly microreticulate, not impressed, as coarsely punctured as head but more sparsely so, with punctures generally separated by their width, and with a central impunctate strip. Elytra quadrate, wider and longer than pronotum; humeri broadly rounded, sides straight and hardly divergent to narrowly rounded exterior apical angles; surface finely, densely, and rather roughly punctured. Abdomen narrower than elytra, tapering slightly to apex; dorsal and ventral surfaces with fine, longitudinal microstrigulation, about as finely punctured as elytra but more sparsely so and not as roughly; last sternite evenly arcuate at apex.

The most important structural difference between this female and the holotype male is in the unmodified apical margin of the sixth sternite, a condition typical of many Staphylinidae. There is also considerable difference in color, some in ground sculpture and in the fact that the surface of the pronotum is not impressed. These latter differences are probably within the range of individual variation for the species and not of sexual significance.—IAN MOORE, *University of California, Riverside, 92502.*